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Knowledge and Willingness to Practice Chairside Buffering of Local Anaesthesia among Nigerian Dental Practitioners: A Cross-Sectional Study

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ABSTRACT

Background: Local anesthetic (LA) chairside buffering has been documented to reduce injection pain, shorten onset time, and improve patient comfort during dental procedures. Consequently, dental practitioners' knowledge and practice of LA buffering could significantly improve dental practice and enhance patients' attendance at dental clinics. This study assesses the knowledge and willingness among dental practitioners in Nigeria to practice chairside LA buffering.

Methods: This cross-sectional study was conducted over 6 months (November 2024 to April 2025). Participants were recruited after obtaining consent and completing a self-administered questionnaire consisting of two domains: knowledge and willingness to practice. The knowledge domain consisted of 10 questions asking participants to select "Yes," "No," or "I do not know" for each question, and each correct response was scored 1 mark, while a wrong or "I do not know" answer scored 0 mark. Total knowledge scores were categorized as low (≤50%), fair (51–69%), or good (≥70%). Five questions were asked in the willingness to practice domain, and responses were analyzed in the order they were asked. Data were analyzed using IBM SPSS software version 25.

Results: A total of 158 respondents completed the questionnaire, giving a response rate of 98.1%. The sample comprised 106 (67.1%) males and 52 (32.9%) females. Most respondents, 96 (60.8%), were in the age range of 31–40 years, and 155 (98.1%) had been practicing for more than 2 years. Resident doctors constituted the highest respondents (80, 50.6%), and the majority (125, 79.1%; 95% CI: 72.0–85.1%) were aware of LA chairside buffering. The overall mean knowledge score was 38.4%, and the majority of respondents (153, 96.8%; 95% CI: 92.9–98.8%) had never practiced chairside buffering of LA, with only 54 (34.2%; 95% CI: 26.9–42.1%) willing to practice it. No statistically significant difference was found between gender and willingness to practice chairside LA buffering ($\chi^2 = 0.632$, df = 1, p = 0.426). The main reason for not willing to practice buffering of LA was extra cost of treatment (45, 43.3%).

Conclusion: While the benefit of chairside LA buffering in providing less painful, more reliable, and comfortable anesthesia has been established, knowledge, practice, and willingness to practice this technique among dentists were found to be low.

Keywords: Local anesthetic buffering, Chairside, Knowledge, Dental practitioners

INTRODUCTION

Local anesthesia (LA) has been widely used in dental practice for pain management.[1] Most of the dental literature suggests that an overwhelming majority (over 90%) of dental procedures are carried out under local anesthesia, as it is considered the standard practice for most dental treatments such as dental restorations, extractions, and periodontal procedures.[2,3]
Local anesthesia in dentistry is commonly achieved through block or infiltration techniques. Several agents, including lidocaine, bupivacaine, etidocaine, mepivacaine, and prilocaine, have been used for this purpose; however, lidocaine remains the most commonly used agent due to its availability, rapid onset of action, smooth course, and favorable safety profile.[4] An ideal local anesthetic agent is expected to possess several properties, including rapid onset, adequate duration of action, reversible effect, minimal tissue irritation, low allergenicity or systemic toxicity, rapid metabolism, and stability at room temperature.[4–6] To enhance these properties, various adjuvants have been incorporated into local anesthetic formulations. Among the commercially available preparations, lidocaine combined with epinephrine remains the most widely used formulation in dental practice because the vasoconstrictor prolongs the duration of action and reduces systemic absorption.[7,8]

Despite the effectiveness of local anesthetics in controlling procedural pain, the administration of the injection itself can be a significant source of discomfort and anxiety for patients. Factors influencing the pain of injection include the speed of injection, injection technique, and the pH of the anesthetic solution.[9] Consequently, efforts have been made to modify anesthetic solutions to improve patient comfort and clinical effectiveness. One such modification is the buffering of local anesthetic solutions at the chairside using sodium bicarbonate to increase the pH of the solution, making it closer to physiological pH. Theoretically, buffering increases the proportion of the non-ionized base form of the anesthetic, which more readily penetrates the nerve sheath and facilitates nerve blockade.[10] As a result, buffered anesthetic solutions may provide faster onset of action, reduced pain on injection, and overall improved patient comfort.[10,11]

However, local anesthetic cartridges are not manufactured with buffering agents because acidic pH is necessary to maintain chemical stability and prolong shelf life.[12] Therefore, when buffering is desired, it must be prepared chairside shortly before administration. The additional step required for buffering has been cited as a barrier to its routine use, limiting widespread adoption despite evidence supporting its safety and effectiveness.[13] While dentists in the United States, Europe, and parts of Asia have increasingly adopted chairside buffering with favorable clinical outcomes and patient feedback, information regarding the awareness, knowledge, and clinical adoption of this technique among dentists in Africa remains scarce, particularly in Nigeria. Abdi et al. reported that non-anesthesia healthcare professionals at Mulago National Referral Hospital had generally poor knowledge, mixed practices, and negative attitudes regarding the safe use of local anesthetics, underscoring the need for improved training and guidelines.[14]

Specifically, it is unclear whether dental practitioners are familiar with the concept of buffered local anesthesia, whether they understand its clinical advantages, and whether they are willing to incorporate the technique into routine practice. Therefore, this study aimed to assess the knowledge and willingness of dentists to adopt chairside buffering of local anesthesia.

METHODS

Study Design and Setting

This was a cross-sectional study conducted among dentists practicing in Nigeria, irrespective of location. The study was carried out between November 2024 and April 2025 using a self-administered questionnaire.

Participants

Inclusion Criteria

- Dentists currently practicing in Nigeria
- Provided informed consent
- Completed the questionnaire

Exclusion Criteria

- Did not provide informed consent
- Incomplete or improperly filled questionnaires
- Non-practicing dentists

Participation was voluntary, and only respondents who provided informed consent were included in the study.

Sample Size

A non-probability convenience sampling technique was used.

The minimum sample size was calculated using Fisher's formula: $n = z^2pq / d^2$, where $z = 1.96$ (95% confidence level), $p = 0.50$ (maximum variability assumed as no prior estimate of recall attendance among denture wearers in Nigeria was available), $q = 0.50$, and $d = 0.10$ (10% margin of error). This study used a 10% margin of error because a 5% margin would have required a minimum sample size of 384 participants, which was not achievable within the two-year study period given the limited number of eligible denture wearers presenting at the participating centers. Therefore, a 10% margin of error was adopted as a pragmatic compromise and is acknowledged as a limitation of this study.

The calculated minimum sample size was 96 participants. The study successfully recruited and analyzed 158 respondents, exceeding the minimum requirement. Using a sample size larger than calculated provided greater statistical power, increased precision (narrower confidence intervals), reduced variability (lower standard error), and better representation of the population, which ensures more reliable and robust results, particularly when accounting for potential participant attrition or high variance in data.

Data Collection and Variables

Data were collected using a structured, self-administered questionnaire. The questionnaire was validated by two consultant anesthetists at Usmanu Danfodiyo Teaching Hospital, Sokoto, to assess content and face validity. Pretests were conducted on five randomly selected dentists to assess clarity and comprehension.

The questionnaire consisted of two domains: knowledge and willingness to practice. The knowledge domain consisted of 10 questions asking participants to select "Yes," "No," or "I do not know" for each question. Each correct response was scored 1 mark equally for all questions, while a wrong or "I do not know" answer scored 0 mark. Possible scores ranged from 0 to 10 marks per participant. Total knowledge scores were categorized as low (≤50%), fair (51–69%), or good (≥70%) as adopted from Bala et al.[15] Five questions were asked in the willingness to practice domain, and responses were analyzed in the order they were asked.

Data Management and Bias Control

Data were analyzed using IBM SPSS version 25. Categorical variables were summarized using frequencies and percentages. Inferential statistics were performed using the Chi-square (χ^2) test to determine associations between demographic characteristics, knowledge levels, and willingness to adopt the technique. A p-value of <0.05 was considered statistically significant.

To minimize bias:

The questionnaire was validated by experts in the field
Pre-testing was conducted to ensure clarity
A standardized scoring system was used
Confidentiality was maintained to reduce response bias

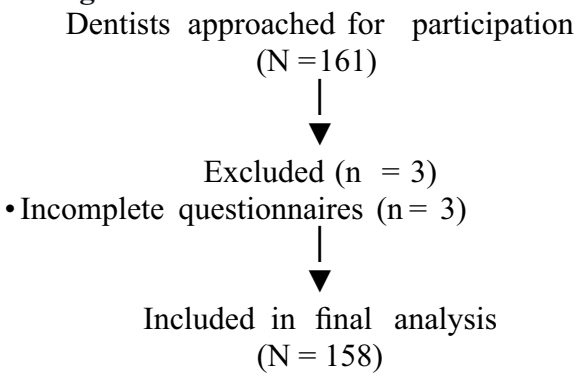
Ethical Considerations

Ethical approval (UDUTH/HREC/2024/NO.800) was obtained from the Research and Ethics Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto. Participants were informed about the study objectives, and informed consent was obtained prior to participation. Confidentiality and anonymity of respondents were strictly maintained.

RESULTS

Of the 161 dentists approached, 158 completed the questionnaire, giving a response rate of 98.1%.

Figure 1: Participant Flow Diagram



Socio-Demographic Characteristics of Respondents

A total of 158 respondents completed the questionnaire, comprising 106 (67.1%) males and 52 (32.9%) females. The majority of respondents, 96 (60.8%), were within the 31–40 years age group, while 155 (98.1%) had been in practice for more than 2 years.

Regarding professional cadre, residents constituted the largest group, 80 (50.6%), followed by dental officers 52 (32.9%), consultants 13 (8.2%), others 8 (5.1%), and house officers 5 (3.1%) (Figure 2). Cross-tabulation between gender and selected variables (age category, cadre, and duration of practice) is presented in Table 1.

Figure 2: Distribution of respondents by professional cadre (n=158)

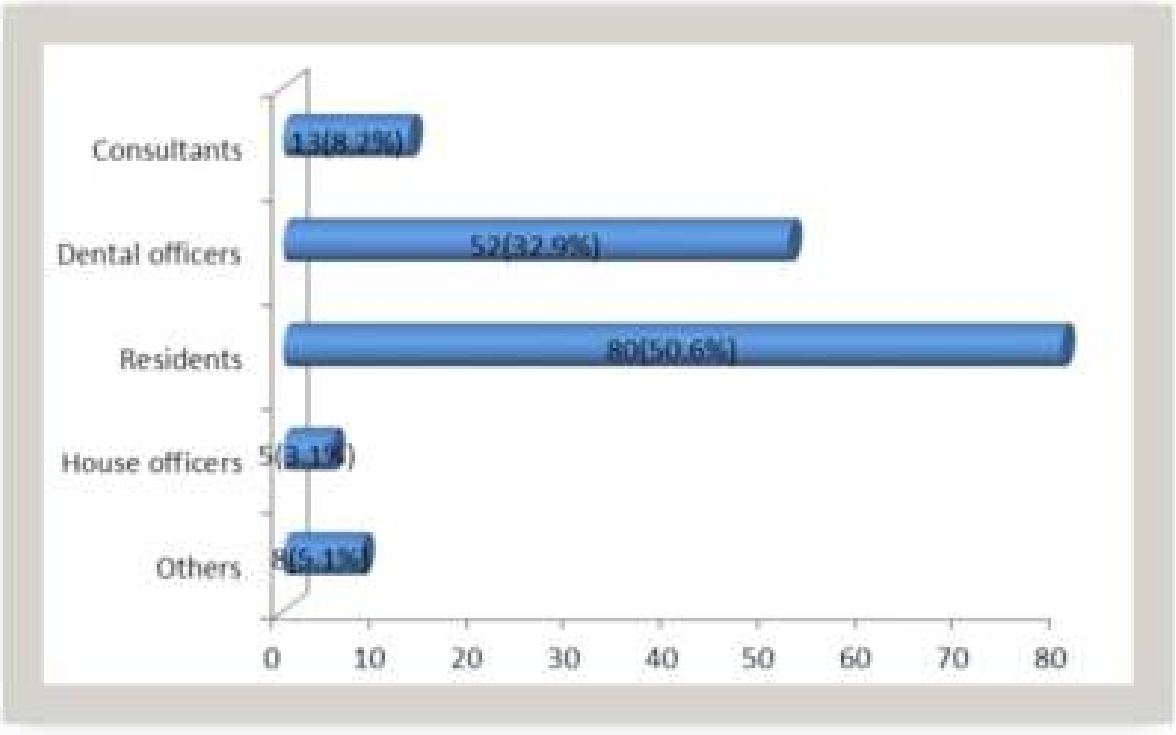


Table 1: Sociodemographic characteristics of respondents by gender

Variable	Male, n (%)	Female, n (%)	Total, n (%)	Test statistics	p-value
Cadre				χ^2 = 16.559, df = 4	0.002
Consultants	13 (8.2)	0 (0)	13 (8.2)		
Dental officers	35 (22.2)	17 (10.8)	52 (32.9)		
House officers	1 (0.6)	4 (2.5)	5 (3.2)		
Residents	49 (31.0)	31 (19.6)	80 (50.6)		
Others	8 (5.1)	0 (0)	8 (5.1)		
Age category				χ^2 = 25.697, df = 2	<0.001
21–30 years	13 (8.2)	20 (12.7)	33 (20.9)		
31–40 years	64 (40.5)	32 (20.3)	96 (60.8)		
>40 years	29 (18.4)	0 (0)	29 (18.4)		
Duration of practice				χ^2 = 0.268, df = 1	0.605
>2 years	105 (66.5)	51 (32.3)	156 (98.7)		
<2 years	1 (0.6)	1 (0.6)	2 (1.3)		
Total	106 (67.1)	52 (32.9)	158 (100)		

Awareness and Knowledge of Chairside Buffering

A majority of respondents, 125 (79.1%; 95% CI: 72.0–85.1%), reported being aware of chairside buffering of local anesthetics, while 33 (20.9%) were not aware. The overall mean knowledge score was 38.4%, which falls within the low knowledge category (Table 2).

Table 2: Knowledge of chairside local anesthetic buffering (n=158)

S/N	Question	Correct response, n (%)
1.	Local anesthetic buffering aims to reduce pain at the injection site	105 (66.5)
2.	Buffering reduces the onset time of local anesthesia	57 (38.0)
3.	Increasing the duration of action of the local anesthetic has been the main reason for LA buffering	43 (27.2)
4.	Sodium bicarbonate is the most common agent for LA buffering	110 (73.3)
5.	Ammonium can be used as an LA buffering agent	45 (28.5)
6.	Mannitol can be used as an LA buffering agent	26 (16.5)
7.	Buffered LA should not be used in acidic tissue, such as infected tissue	100 (63.3)

8.	The Onpharma system is an example of a buffering device	35 (22.2)
9.	The Anutra system is an example of a buffering device	65 (41.1)
10.	Hand mixing can be done in LA buffering	21 (13.3)
	Total	**607 (38.4%)**

Practice of Chairside Buffering
Most respondents, 153 (96.8%; 95% CI: 92.9–98.8%), had never practiced chairside buffering of local anesthesia, whereas only 5 (3.2%) reported having practiced the technique.

Perception of Chairside Buffering
When asked whether chairside buffering could improve dental practice in Nigeria, the majority responded negatively: No: 127 (80.4%), Yes: 21 (13.3%), and Maybe: 10 (6.3%). However, 107 (67.7%; 95% CI: 59.9–74.8%) of respondents believed that chairside buffering should be practiced by dentists across all cadres.

Willingness to Practice Chairside Buffering
A majority of respondents, 104 (65.8%), were not willing to adopt chairside buffering as a routine part of dental practice, while 54 (34.2%; 95% CI: 26.9–42.1%) expressed willingness.
There was no statistically significant association between gender and willingness to practice chairside buffering (Table 3).

Table 3: Association between gender and willingness to practice chairside LA buffering

Willingness to practice chairside LA buffering*	Male, n (%)	Female, n (%)	Total, n (%)	Test statistics	p-value
Yes	34 (21.5)	20 (12.7)	54 (34.2)	χ^2 = 0.632, df = 1	0.426
No	72 (45.6)	32 (20.3)	104 (65.8)		
Total	106 (67.1)	52 (32.9)	158 (100)		

*WPCLAB = Willingness to practice chairside local anesthetic buffering

Barriers to Practice
Among respondents who were not willing to practice chairside buffering (104; 65.8%), the reasons cited included:
Extra cost: 45 (43.3%)
Lack of mixing devices: 23 (22.1%)
Perceived lack of added value: 15 (14.4%)
Other reasons: 21 (20.2%)

DISCUSSION

Findings: Pain remains the most common reason for patients' presentation to the dental clinic, and its management constitutes one of the most important aspects of dental practice.[16] Dental procedures are frequently associated with anxiety, particularly when injections or local anesthesia are anticipated.[17] Consequently, dental practitioners are continually challenged to deliver painless and comfortable treatment, with local anesthesia forming the cornerstone of pain control in dental care. Effective and atraumatic administration of local anesthesia is therefore essential for successful dental practice.

To achieve optimal pain control, dental surgeons must remain knowledgeable about emerging techniques and modifications that improve the effectiveness and comfort of local anesthetic delivery. One such modification is the buffering of local anesthetic solutions using sodium bicarbonate. Previous studies have demonstrated promising outcomes with this technique, including reduced pain during injection, faster onset of anesthesia, and improved patient comfort during dental procedures.[18–20] Buffering increases the pH of the anesthetic solution, thereby increasing the proportion of the non-ionized form of the drug that more readily penetrates the nerve membrane and enhances the anesthetic effect.

Despite these documented advantages, chairside buffering of local anesthetics has not been widely practiced routinely. This study was therefore conducted to evaluate the level of knowledge and willingness of Nigerian dentists to adopt chairside buffering of local anesthetic solutions in clinical practice.

The findings of this study revealed that the overall knowledge of chairside local anesthetic buffering among respondents was 38.4%, which can be considered low. Several factors may explain this limited awareness among dental practitioners. These include inadequate exposure to the concept during undergraduate or postgraduate training, limited availability of continuing professional education on newer anesthetic techniques, and the persistence of established clinical practice patterns that may discourage the adoption of newer innovations.

Furthermore, the responses obtained from the questionnaire indicated that the majority of respondents had never practiced chairside buffering of local anesthetic solutions. Many participants also perceived that the technique might not significantly improve dental practice within the Nigerian context. Cost was identified as the main barrier to its adoption. Other reported barriers included limited awareness and knowledge of the technique and lack of access to commercial buffering devices such as the Onpharma and Anutra buffering systems, which are primarily available in the United States and may not be readily accessible in many developing countries.

To address these challenges, alternative approaches suitable for resource-limited environments have been proposed. For instance, hand mixing of sodium bicarbonate with local anesthetic solution under strict infection control protocols has been described as a feasible improvised method of buffering. This technique was introduced by Bala et al.[21] to facilitate the adoption of chairside local anesthetic buffering in developing countries where commercial buffering devices are not available. Such adaptations may help familiarize clinicians with the technique and encourage its gradual integration into routine practice.

Similarly, Sriram and Kumar,[22] in their study titled "Efficacy of Buffered Local Anaesthetics in Dental Practice," emphasized the importance of dental practitioners updating their knowledge on modern anesthetic practices to ensure the most effective and comfortable delivery of local anesthesia. The principle underlying local anesthetic buffering stems from the fact that most local anesthetic solutions are stored and marketed in an acidic form to enhance stability and water solubility. Because sodium bicarbonate is not incorporated into commercially available cartridges, the buffered solution must be prepared immediately before administration, or within 24 hours of preparation, to maintain optimal effectiveness.

Implications: These findings highlight the need to improve awareness and training on modern local anesthetic techniques among dentists in Nigeria. Incorporating chairside buffering into dental education, postgraduate training, and continuing professional development programs may enhance practitioners' knowledge and encourage its adoption in clinical practice. Increased awareness and utilization of this technique could improve patient comfort and the overall quality of dental care.

Trade-Offs (Limitations): This study has some limitations that should be considered when interpreting the findings. The use of convenience sampling may limit the generalizability of the results to the broader population of dentists. In addition, the reliance on self-reported data may introduce reporting and social desirability bias. The study was conducted in a single-country setting, which may restrict the applicability of the findings to other regions. Furthermore, the cross-sectional design captures responses at a single point in time and therefore does not allow causal relationships to be established.

The use of a 10% margin of error rather than the conventional 5% represents a limitation of this study, as it reduces precision. Additionally, the use of convenience sampling rather than probability sampling may introduce selection bias, and the sample size calculation assuming maximum variability (p=0.50) may not reflect the true proportion of recall attendance in the population. However, the achieved sample of 158 exceeded the calculated minimum of 96, partially mitigating concerns about statistical power.

Take-Home (Conclusion): This study demonstrated a low level of knowledge and limited adoption of chairside buffering of local anesthetic solutions among dentists in Nigeria. Despite the potential benefits of buffered local anesthesia in reducing injection pain and improving onset of action, its use in routine dental practice remains uncommon. Increased awareness, training, and access to practical buffering techniques may help promote its adoption and improve the quality and comfort of dental care.

Expectations for Future Research: Future studies should involve larger and more representative samples across multiple regions to provide a broader understanding of dentists' knowledge and practices regarding chairside buffering of local anesthetic solutions. In addition, clinical studies evaluating the effectiveness, feasibility, and patient outcomes associated with buffered local anesthesia in Nigerian dental settings are recommended. Such research would help generate stronger evidence to guide clinical practice and policy development.

Recommendations: It was obvious that dentists have low knowledge of chairside LA buffering which in turn led to lack of practice. Continuing dental education with the aim of providing core concepts of LA buffering is recommended to all practicing dentists.

Availability of Data: The data used during this study are available upon reasonable request.
Source of Funding: Nil received.
Conflicts of Interest: None declared

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